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THE NAVY'S OCEANOGRAPHIC PROGRAM[1]

THERE is no line of investigation in which so many different forms of science play a part as in the study of the sea.

What is known as oceanography contemplates investigation of the waves and tides and currents and of all the physical and chemical properties of water, both pure and with various substances in solution or suspension. It also includes the study of the erosion of the shore lines and the change in bottom contours as well as of the piling up of sediments, organic and inorganic, on the ocean bottom and of the resulting alteration in the isostatic balance. It further covers the investigation of the evaporation from the surface of the water, and of the circulation of the air above it. And an important part of oceanography is the study of the plants and animals of the sea, of the relationships between them and of the relationships of both to the physical and chemical features, fixed or variable, of the medium in which they live. Oceanographic observations are of value only if we know the exact spot where they were taken. The localities are determined by recourse to applied astronomy and various forms of mathematics.

IMPORTANCE OF THE STUDY OF OCEANOGRAPHY

From the sea each year we draw an enormous quantity of food, mostly in the form of fish, shellfish, crabs and lobsters. In order to conserve these food resources and further to develop them we must know just how these creatures live, what they feed upon, their habits and the habits of their parasites and enemies, and their relation to salinity and temperature.

Other peoples use sea plants and animals far more extensively than we. Millions of their population find a livelihood in reaping harvests of sea organisms unused by us, and millions more on land profit by their labors.

Each year the rivers of the world carry to the sea millions of tons of mud taken from the surface of the land, and millions of tons of salts in solution in their waters. By this continuous process an enormous total weight of soil and salts is being constantly removed from the land areas. The soil, in the form of mud and sand, is dumped upon the ocean bottom, while the dissolved salts increase the weight of ocean water both by their own added weight and by gradually di-

[1] Read at the General Session of the American Association for the Advancement of Science on December 30, 1924.

minishing the amount of evaporation from its surface, thus adding to the ocean's bulk. Much of the dissolved material brought to the sea by rivers goes to form the shells of billions of small creatures which when they die fall upon the ocean floor, covering millions of square miles of bottom.

The continuous subtraction of vast masses of material from the land and their addition to the weight of the ocean basins in which they are very unequally distributed necessitates constant or intermittent readjustments to maintain an equilibrium or condition of isostasy between the land and sea.

So far we have not attempted to appraise the effect upon us of the transference of material from our land area to the ocean basins, nor do we know the percentage of the loss in soil fertility of our farm lands which is recoverable in the bodies of the fish and other creatures caught along our shores.

From the surface of the oceans water vapor constantly is rising which passes to the air above. This water vapor by the winds is carried inland where, condensing in the form of rain, it makes possible the growth of plants and through them of animals. In other words our agricultural and associated industries depend for their existence upon conditions in the seas surrounding us. The rain which nourishes the farmers' wheat and the water which he gives his cows are merely wandering bits of ocean, from which they came and to which they will return after they have served their purpose to the farmer.

Evaporation from the surface of the sea depends on temperature. On a warm day in summer the hot attic of a house is very dry, but the cool cellar damp, for air when cool can not hold nearly so much moisture as it can when warm. It also depends on the salinity or amount of salts contained, for the greater the amount of salts dissolved the less will be the vapor pressure or the amount of water vapor given off.

Regarding the temperatures and salinities of the seas about our coasts we have but little information sufficiently exact for present-day requirements, nor do we understand the details of the seasonal and daily changes.

The climate of our coastal regions is to a very large extent dependent upon conditions in the seas adjacent, upon the great warm ocean currents like the Gulf Stream and Kuro Siwo or upon cold currents coming from the north or flowing upward from the ocean's depths. These all require much more extended study, with much more accurate instruments than have been available heretofore, and with more regard to the details of the contours of the bottoms over which they flow, which are as yet inadequately known.

There are various other features connected with the sea which are of prime importance to the dwellers on the land. But we have said enough to show that the details of the oceanography of the seas surrounding us provide a most inviting field for research and also that whatever aspect of the problem may be studied our people as a whole will benefit.

Oceanography in its Relation to Governmental Establishments Other Than the Navy

In order properly to appreciate the navy's plan for cooperative oceanographic work it is necessary first to mention the other branches of the government service which are more or less directly interested in a study of the sea.

First comes the army. The efficient laying and maintenance of cables, a vital factor in communications, is to a large extent dependent on accurate surveys of the contours of the ocean bottom. The operation of the army transport fleet has much to gain from a better knowledge of marine conditions. More accurate knowledge of the relation of the sea to the atmosphere above it would aid our coast defenses.

The Coast Guard is charged with the responsibility of maintaining the international Ice Patrol, a most important duty undertaken with the object of protecting the shipping on the north Atlantic lanes and supported by contributions from the several nations interested. Icebergs and ice in order to be conquered must first be understood, and the ice problem is an important field for research in polar oceanography.

From the nature of its duties the Coast Guard also is concerned with other phases of oceanographic work. In this connection it will be recalled that the first deep water work done by the Fish Commission in 1871 was carried out from the cutter *Moccasin* loaned by the revenue cutter service, now merged with the Coast Guard.

The Coast and Geodetic Survey is vitally interested in all lines of oceanographic work. Especially important is information on the configuration of the ocean bottoms, magnetic and gravity observations, tidal observations on the islands of the ocean and in ports not often visited for which we have as yet insufficient data on which to base accurate tide predictions, temperatures and salinities from the surface to the bottom, and any data which may be obtained in regard to currents, tidal, wind-driven, or resulting from other causes.

Historically it is interesting to recall that the inception of oceanographic work by the government of the United States dates from an order issued by the then director of the Coast Survey, Alexander Dallas Bache, in 1844; and furthermore that it was the Coast Survey, in 1867 under Count Pourtales in the *Corwin,* that first commenced the intensive study of deep water animals, the year before the same work was begun in England in the *Lightning.*

The Bureau of Fisheries is charged with the in-

vestigation and development of our fisheries resources. So far as its work concerns the sea all information of whatever sort bearing on marine conditions is vitally important to it. Throughout their entire lives sea plants and animals are absolutely dependent on the medium in which they live. They breathe the air in it, they take their food from it, directly or indirectly, and they make their skeletons from substances dissolved in it. Therefore, anything that can be discovered about the physics and chemistry of the ocean, about the bottom contours or about the shape and changes in the shore lines is of importance to this bureau. In fact, it is not conceivable that anything could be found out about the sea that would not have some bearing on the bureau's work.

In its early days, as the U. S. Fish Commission, this bureau did a great deal of oceanographic work in ships loaned for the purpose by the Coast Guard and the Revenue Cutter Service. Later, in 1880, the *Fish Hawk*, still in service, was constructed, and in 1883 the *Albatross*, sold last summer, commenced her notable career during the course of which she worked along the entire western shore of the Atlantic from Newfoundland to the Magellan Straits, the entire eastern shore of the Pacific, in the Bering, Okhotsk and Japan Seas, in the Philippines and the Moluccas and throughout much of Polynesia.

No work has proved of greater value to the people as a whole than the study of geology, which falls within the province of the Geological Survey. But our knowledge of the geological and the geographical features of the earth's surface practically ends at the shore line. The detailed mapping of the topography of the ocean bottom will almost certainly bring to light systems of mountain ridges, terraces, escarpments and benches, old shore lines, uplifts, submarine volcanoes, fault scarps, peneplains, etc., showing deformations of the ocean bottom and indicating much of its history, particularly in later geologic times. It should give us the data from which to reconstruct portions, at least, of the history of the changes in shape, size and depth of the oceanic basins, all of which are determined by deformation and uplifts or subsidences of the land masses which border and underlie these basins. It should furnish information not only regarding former land connections effected through changes of the shore lines or by uplifts of one area or another, but also concerning the changes in the epicontinental seas in regions now submerged; also as to oceanic currents and interoceanic connections in the past by which marine life migrated during one period or another and by which the present distribution of sea life is explained. Detailed knowledge of the ocean bottom should reveal the source and exact location of many of the earthquakes, the positions of which are now but very roughly estimated; and it should bring to light centers of submarine volcanic action in which islands may be in process of building, or perhaps of destruction, and from which tidal waves will travel. The study of the bottom sediments, of their composition and the rate of deposition, has of course an important geologic bearing, and much attention has heretofore been devoted to this in the Geological Survey. Of great interest also to geologists is the relative proportion of the various salts in ocean water; this too has been studied by the Geological Survey.

The Weather Bureau is interested in oceanographic work in much the same manner and to much the same degree as the Geological Survey. There is need for much more precise information on the surface temperatures, especially in certain regions. The relation of the winds and currents, and between the winds at different heights above the sea, requires much more detailed study than has as yet been possible. Tropical cyclones offer interesting problems for investigation, and there are almost innumerable other features of the meteorology of the sea which as yet are by no means fully understood.

The Smithsonian Institution is the legal repository of the collections brought together by the various governmental agencies, these collections being stored in the U. S. National Museum. The material brought back by oceanographic expeditions in the main consists of various forms of plant and animal life, and of samples of the bottom sediments.

The permanent preservation of these specimens is most important. They are the original standards in terms of which sea life is described.

Physical and chemical observations are recorded in terms of definite concepts based on mathematical formulae, on definite chemical reactions, or in some cases in terms of well-known standards carefully preserved somewhere.

At best only a very general concept can be formed of any animal or plant. No description of any species ever was drawn up which proved more than approximately adequate. Any given animal is so complex that it can only be described approximately. Furthermore, no two individual animals are ever quite alike, and often the two sexes differ widely; while all animals pass through various different forms in the course of their life history. Every day or so the disconcerting fact is demonstrated that the available description of some animal or other is vague or lacking in some feature essential to its proper comprehension. With the yearly increase in the number of the plants and animals we know and of the variations and the different forms of each, an increasingly greater number of the earlier descriptions prove

inadequate, and we would be wholly lost were it not possible for us to reexamine the material which served as the foundation for the earlier work.

Comparison of one sea area with another is only possible if we know the two have been described in strictly corresponding terms, reducible to the same standards. In biology we never can be sure of this unless we have at hand examples of those standards.

An important function of the National Museum is to secure, through gift, exchange or purchase, as large a series as is possible of sea animals from distant regions described in foreign works which, through comparison with material from other regions and from home waters, will enable us to understand and to interpret the relative conditions in our seas.

The Astrophysical Observatory is concerned with everything bearing upon emanations from the sun and from the other heavenly bodies. It is therefore keenly interested in all information that can be obtained regarding the temperature and other physical features of the ocean water.

It is scarcely necessary to remark that the Shipping Board and Fleet Corporation, and the merchant marine in general, are greatly interested in any work that will reduce the dangers of navigation.

Very many of the bureaus of the government would be greatly aided in carrying on their work by the facilities for transportation and for the assembling of material resulting from naval oceanographic work, especially in various regions not accessible through commercial means of transportation.

The Necessity for Interdepartmental Cooperation

From the foregoing it is evident that any plan contemplating oceanographic research by the navy must be a cooperative plan. Some branches of the government service, as the Coast and Geodetic Survey, the Bureau of Fisheries and the Coast Guard, are at present carrying on important oceanographic work, each along special lines and with special ends in view. There must be no interference with their operations—no demoralizing competition. Other branches of the government service, as the Geological Survey and Weather Bureau, and the National Museum, are not engaged in oceanographic work but are anxious to avail themselves of any opportunity for gathering data from the sea.

The Navy's Early Oceanographic Work

The earliest American achievement in oceanographic research was the publication in 1770 of a chart by Benjamin Franklin on which he showed the course of the Gulf Stream.

With the expansion of our merchant marine in the early eighteen hundreds our interest in the ocean as a whole rapidly increased. In 1807 Congress passed an act authorizing the President to cause the whole of the coast and harbors of the United States, with adjacent islands, to be surveyed and soundings taken, appropriating $50,000 for the purpose. The President entrusted the Secretary of the Treasury with the task of carrying out the provisions of this act. In 1816 Congress reenacted the appropriation, and the Coast Survey came into being.

But a knowledge of the seas of all the world was just as important for our shipping as a knowledge of our coasts and harbors, and the duty of investigating these naturally devolved upon the navy. These investigations followed two main lines, each undertaken with marked success.

The first line consisted in organizing great exploring expeditions which were sent to distant regions. Among these were the United States Exploring Expedition, authorized by Act of Congress in 1836; the exploration and surveys in the valley of the Amazons authorized in 1851; the United States North Pacific Surveying Expedition authorized in 1852; the exploration of the valley of the Rio de la Plata and its tributaries authorized in 1853; Hall's Arctic Expedition, for which Congress made appropriations in 1870; and the *Jeanette* expedition of 1879.

The second line was the less spectacular intensive study of the sea. This was developed almost wholly through the efforts of Matthew Fontaine Maury.

Maury entered the navy as midshipman in 1825 and in a cruise of 4 years' length circumnavigated the globe. In 1836, now a lieutenant, he served as astronomer on the United States Exploring Expedition. In 1839 he met with an accident which made him permanently lame, and was placed in charge of the Depot of Charts and Instruments, which he thoroughly reorganized and out of which have grown the United States Naval Observatory and the Hydrographic Office.

While on his cruise around the world on the *Vincennes* and on subsequent cruises Maury made many observations on the winds and currents, and when in charge of the Hydrographic Office he set himself the task of collecting further data by distributing to ship captains log books especially prepared. So successful was he in this enterprise that in the course of nine years he had collected enough logs to make 200 volumes each with about 2,500 days' observations. One result of this investigation was to show the necessity for combined action on the part of maritime nations in regard to ocean meteorology. This led to an international conference at Brussels in 1853, which resulted in the greatest benefit to navigation. Besides his pioneer work in meteorology, which he was the first to show could be regarded as a science, Maury

made notable contributions to the study of the ocean basins. The first bathymetric chart of the North Atlantic was published by him in 1854.

The preparation of this chart had been rendered possible through the ingenuity of Midshipman Brooke, who had devised a simple mechanism for the detachment of the heavy weight by which the sounding line is carried down when it struck the bottom.

After Maury left the navy oceanographic work was largely discontinued, not from any lack of appreciation of its value by the navy or by Congress, but because the fighting ships had entered the period of transition from wooden ships to ironclads and because of the rapid changes being made in the design and the rapid increase in efficiency of marine engines. In this period of transition from wooden sailing ships with engines of low power to steam-driven iron ships the navy naturally had to concentrate all its energies on purely military matters.

It was at this time when the navy was preoccupied in other lines that the detailed study of the ocean's depths was first begun by the Coast Survey and four years later by the Fish Commission in a new form, that of biological oceanography.

When the design and the construction of the fighting ships had reached a period of relative stability the navy again undertook oceanographic work, this time largely in connection with bottom surveys over proposed cable routes.

In the course of these cable surveys a second great advance was made in the method of depth determination. In the early seventies Commander Belknap on the *Tuscarora* first made practical use of fine piano wire in taking soundings instead of slender ropes, by this means saving much time in every operation and much storage space.

The Sonic Sounder

Quite recently there has been developed in the Navy by Dr. H. C. Hayes a most ingenious and extraordinary mechanism by which the depth of water underneath a ship is found by the emission of a sound wave which is echoed from the bottom.

Not only does this method do away with the necessity of handling long lines and heavy weights, difficult in a rough sea, but it makes possible a record of scores of observations where only one was possible before, and in addition the observations are of greater accuracy.

Its practical value has received abundant confirmation on various transatlantic lines, in the preparation of a detailed contour map of the bottom off southern California, in a survey for a new Alaskan cable route and in other operations.

The Conference on Oceanography

With the perfection of this wholly new device there naturally arose a wish for its extensive use in a more detailed and more accurate survey of the sea bottom than has hitherto been possible.

Furthermore a ship equipped with this device and running lines of soundings could at the same time accommodate sufficient men to carry on various other lines of research work connected with the sea and perhaps of more immediate value to the people on the land.

Having in mind the far-reaching possibilities of a broad oceanographic program and the value to the country of Lieutenant Maury's work, Dr. Hayes on February 19, 1923, prepared a letter suggesting the adoption by the navy of a definite plan for oceanographic work, which received the hearty endorsement of all the officers concerned and was approved by the acting secretary of the navy, Colonel Theodore Roosevelt, Jr.

Under his direction a detailed study was made of the subjects requiring investigation for the benefit of the navy and the best means of undertaking this work. The desirability of concentrating, intensifying and extending the research and experimental work carried on by the navy in connection with the various problems presented under the general heading of oceanography had been realized and constantly recommended for a long time, and it was believed that scientific investigation along these lines should no longer be delayed.

After a preliminary study of the general proposition of oceanographic research by the navy Colonel Roosevelt saw that such work by the navy might be of value in collecting data or in making special investigations for other governmental establishments.

With this idea in mind and with a view to ascertaining the possibilities of interdepartmental cooperation in the navy's project he sent a letter on June 2, 1924, to the secretaries of the other departments, the secretary of the Smithsonian Institution, the president of the National Academy of Sciences, the secretary of the National Research Council, the librarian of Congress, the president of the Carnegie Institution, and the chairman of the United States Shipping Board, requesting them to nominate representatives to take part in a general conference on oceanography to be held in the Navy Department on July 1, 1924.

The main object of this conference was to ascertain how best the interests of all the government bureaus could be served through oceanographic research by the navy; how they could all work together and how the navy best could proceed without intruding

into any field properly falling within the sphere of some other agency.

The conference, at which 46 representatives of the government departments and the extra-governmental establishments named were present, was opened by an address by the Honorable Curtis D. Wilbur, the secretary of the navy.

The temporary chairman, Capt. F. B. Bassett, then traced the events culminating in the conference, and emphasized the importance of oceanographic work.

Dr. George W. Littlehales, the hydrographic engineer of the navy, followed with the keynote address.

The conference then chose as president Captain F. B. Bassett, hydrographer of the navy, and as secretary-general Lieutenant Commander G. E. Brandt, aide to the hydrographer.

A series of addresses by the representatives of the various departments followed, intermingled with discussion of various points, the proceedings being characterized throughout by a keen appreciation on all sides of the value of the work proposed and a remarkable spirit of cooperation.

An executive interim committee was selected to prepare a report for the consideration of the conference.

This committee held two meetings and submitted the following report, which was unanimously adopted.

REPORT OF THE CONFERENCE ON OCEANOGRAPHY TO THE HONORABLE THE SECRETARY OF THE NAVY

General Considerations

The conference is profoundly impressed with the importance of beginning, as soon as possible, a national cooperative program of research in oceanography, having as the principal aim the accomplishment of results of practical economic value.

It is realized:

(1) That five sevenths of the earth's surface is covered with the waters of the ocean.

(2) That the physical conditions of these waters and their circulation largely determine the weather and climate over land areas and, consequently, the productivity of the soil.

(3) That the food and other plant and animal resources of the ocean at present unexploited are enormous.

(4) That these resources have not been fully used by man because of a lack of knowledge of their extent and of practicable means of applying them to economic use.

(5) That indications are that the products of the land will not be able to keep pace with increases in population, thus requiring a greater exploitation of the resources of the sea.

(6) That the first requisite to practical scientific studies in oceanography is a knowledge of the shapes of the ocean basins, the contours of the bottom and the depths of the water in different places.

It is, therefore, the opinion of this conference that a survey and inventory of the resources of the sea, as indicated above, will give results of much practical and scientific value. They may be discussed in the following detail:

Definite Objects

Preliminary to entering upon the details of its recommendations, the conference laid down the following definite objects to be attained:

(1) Discovering, developing and utilizing the resources of the sea.

(2) Facilitating navigation of the sea and of the air and improving communication by radio and by submarine cable.

(3) Promoting the welfare of mankind through scientific discovery and the progress of knowledge.

(4) Safeguarding human life.

Area of Operation

It is the opinion of the conference that investigations promise results of the greatest practical and scientific value if devoted to intensive study of selected regions or problems.

It is recommended that the first work be devoted to the Gulf of Mexico-Caribbean region, and the neighboring parts of the North Atlantic, extended through the Panama Canal into the Pacific; subsequent work to be done in the waters of the North Pacific and North Atlantic Oceans.

Vessels

It is recommended that a naval vessel or vessels be permanently assigned to oceanographic work. Such vessels should, if practicable, have twin screws and low free-board, and must have a large cruising radius. They should have laboratories and sufficient living quarters and cabins comfortably to accommodate the personnel.

While the above requirements are preferred, the conference desires to state that any suitable vessel or vessels that the Navy Department may assign for this purpose will be acceptable.

The cost of putting a vessel in commission being dependent upon the type of vessel assigned, no estimate is made by the conference at this time.

Equipment

It is assumed that the equipment supplied to naval vessels will be furnished, and that the latest type of sonic depth finders and radio will be installed. Certain additional special materials and equipment will be necessary, and for these the committee after a detailed study submits an estimated cost of $50,000.

Personnel

The officers and crew of the vessel should come from the naval personnel. In addition, it is recommended that for the first work the following specially selected scientific personnel be employed:

1 oceanographer,
1 biologist,
1 geologist,
6 or more scientific assistants.

The first three should be men of outstanding attainments, each eminent in his own field of knowledge. The assistants may be drawn from the younger scientists connected with universities, colleges and other institutions. The pay of the above-mentioned scientific personnel, it is expected, will be provided from sources outside of the government. Allowance must be made, however, for subsistence while actually engaged in the field and for travel expenses to and from their homes, estimated at an annual cost of $7,500.

RECAPITULATION OF COST

Special equipment and supplies (first year)	$50,000
Subsistence and travel for scientific personnel	7,500
Total estimated cost	$57,500

SCIENTIFIC PROBLEMS TO BE TAKEN UP

The shapes, contours and depths of the ocean basins.

Distribution of temperatures, densities and salinities on the surface and in the depths of the oceans, together with the periodic or other changes which occur.

Evaporation and precipitation (rain, fog, snow) over sea and land areas.

The distribution and periodic changes in atmospheric pressures and winds.

The ocean currents and the vertical circulation of ocean waters.

The chemistry of sea-water, the hydrogen-ion concentration and the sources and distribution of nitrogen, etc., in the sea.

Changes in the size and shape of the bottoms of the seas, such as shifting of shore lines, warping of the margins of the continents and submarine upheavals and dislocations.

Nature and composition of the formations of the sea bottom.

Previous land connections and changes in existing connections between continents.

Areas and features of submarine volcanism and earthquake movement.

Sedimentation.

The penetration and diffusion of light in sea water under various conditions and its bearing on plant and animal life.

The distribution of the intensity of gravity.

The distribution, relative abundance and interrelations of the various forms of plant and animal life.

Visibility under different conditions of the atmosphere.

Height, length and velocity of ocean waves.

Location and extent of fields of static and of electromagnetic disturbances and investigations of other forms of atmospheric electricity.

PRACTICAL AND ECONOMIC RESULTS TO BE DERIVED FROM THE SCIENTIFIC INVESTIGATIONS

New fishing banks, when developed, will add to the welfare of mankind. Scientific methods applied to the development and use of fisheries resources will increase production and insure permanency.

A full understanding of the climate and the developing of better means of predicting weather conditions, particularly the periods of rainfall and drought and their duration, will enable better control of the agricultural production of the land.

The solution of weather problems affecting navigation of the sea and of the air.

A full knowledge of the ocean and tidal currents and of the drift of icebergs will better safeguard shipping and be of value to fishermen in their operations.

A knowledge of ocean depths and bottom contours will aid navigation and fishing and will indicate the most economical and advantageous cable routes.

Knowledge of sedimentation and of the action of tides, winds and waves will aid effective and economical construction and maintenance of navigational channels and harbor works.

Greater knowledge of the profiles and velocities of waves will lead to better design of ships to secure the necessary strength.

Additional knowledge of the density of waters in all parts of the oceans will lead to a clearer understanding of ocean currents, a higher precision in sonic depth sounding and the more accurate design of underwater devices.

Knowledge of the visibility over all parts of the oceans will aid navigation and the design of observing apparatus.

The location of deposits of oil, ores and other resources of economic importance.

The improvement of radio communication and the reduction in the cost of operating radio stations.

The improvement in the radio compass stations and other practical aids to safe navigation of ships and of aircraft.

DISPOSITION OF SPECIMENS

Specimens of scientific importance will be transferred to the U. S. National Museum for study, exchange or other disposition as mutually agreed upon by the Navy and the museum.

PUBLICATION

The publication of data collected and the results of analyses and interpretations will be under such regulations as the Secretary of the Navy may prescribe.

PERMANENCY

The recommendations embodied in this report are based upon the expectation that research in oceanography will take a permanent place among the activities of the Navy.

SONIC DEPTH FINDER CHART

There being now at hand a ready means of rapidly determining ocean depths in the sonic depth finder invented by Dr. Harvey C. Hayes and developed by the U. S. Navy, it is urged that vessels fitted with the sonic depth finder undertake the preparation of a detailed chart of the Gulf of Mexico-Caribbean area showing the contours of the bottom. This chart should be available when the oceanographic researches begin.

NAME

The conference recommends that this oceanographic undertaking be known as the Maury U. S. Naval Oceanographic Research, in honor of Lieutenant Matthew Fontaine Maury, U. S. Navy, whose pioneer work in practically all branches of oceanography entitles him to this distinction. It is further recommended that the major ship that is assigned to this work be named the U. S. S. *Tanner* in honor of Commander Zera L. Tanner, U. S. Navy, whose long-continued oceanographic work has contributed much to the advance of this science.

CONTINUING ADVISORY COMMITTEE

It is recommended that, in order to carry the project through the initial stages, to properly present this case to the Navy Department, the Budget and the Committees of Congress, and to develop the organization of the first cruise, provided funds and ships are available, the Secretary of the Navy appoint a continuing advisory committee consisting of representatives of governmental and other institutions interested in the investigations to be undertaken, and that Captain F. B. Bassett, U. S. Navy, and Lieutenant-Commander George E. Brandt, U. S. Navy, respectively, be the chairman and secretary of this committee.

The continuing advisory committee recommended by the conference was immediately appointed by the Secretary of the Navy.

CONCLUSION

No plan for broad cooperative work which has been proposed in recent years offers such possibilities of benefit to all as the Navy's plan for oceanographic work. No precedent is involved in its adoption, for in times of peace oceanographic studies heretofore have always been an important part of the Navy's duties.

With these closing words I commend the plan to you as most worthy of your consideration and support.

AUSTIN H. CLARK

SMITHSONIAN INSTITUTION,
WASHINGTON, D. C.

THE REPORT OF THE COMMITTEE ON FREEDOM OF TEACHING IN SCIENCE

THE American Association of University Professors, at its recent meeting in Washington, endorsed the appended statement of Committee M on "Freedom of Teaching in Science." This committee was formed on account of efforts which have been made to suppress the teaching of doctrines which incurred the disapproval of some organized groups. It can not be denied that a private institution is within its legal rights if it does not tolerate any of its members who do not believe that the world is flat, although such a policy might be inimical to progress and suicidal in the long run for the institution itself. It is, however, a different matter when a public institution becomes guilty of a similar policy of suppression in regard to any sort of theoretical question.

The situation that has arisen in America has been commented upon with some amusement by several writers abroad as a very anomalous development among a people who do so much talking about liberty. It indeed seems necessary to call attention to some fundamental principles by which the people of a democracy should be guided in the toleration of opinions. It is for this purpose that the following statement was formulated.

S. J. HOLMES

The Statement of the Committee

The last few years have witnessed a revival of the spirit of intolerance which has asserted itself especially in the opposition to the teaching of evolution. Attempts have been made to secure the passage of laws forbidding such teaching in state-supported institutions of learning, and teachers of biology in a number of colleges have been dismissed on account of their promulgation of evolutionary doctrines. These occurrences have aroused in the teaching profession, and also in the general public, considerable concern over the maintenance of that freedom of thought and speech which Americans have regarded as one of their most valued possessions. Recent events have demonstrated that public opinion in several parts of the United States is considerably less enlightened than had commonly been supposed, and manifestations of intolerance which we had generally come to believe were no longer possible have been of not infrequent occurrence. There are, in the opinion of the Committee on Freedom of Teaching in Science, certain general principles by which we should be guided in regard not only to the teaching of evolutionary theory, but in all other fields of inquiry. Notwithstanding the fact that the doctrine of evolution in some form is accepted by practically all competent investigators in every branch of biological science, it is not so much for this reason that the attempts to suppress the teaching of evolution should be condemned as the fact that such attempts strike a blow at the fundamental principle of freedom in teaching and research. Opposition to the teaching of evolutionary theory is based mainly on ignorance and groundless fears. But the worst feature of the opposition is not that it is unscientific, but that it is un-American.

It is, we believe, a principle to be rigidly adhered to that the decision as to what is taught as true, or what should be presented as theory in science or in any other field of learning, should be determined not by a popular vote nor by the activities of minorities who are persuaded that certain doctrines are inconsistent with their beliefs, but by the teachers and investigators in their respective fields. It would be absurd for the laity to attempt to dictate to the teachers of medical science what should and what should not be taught as facts in colleges of medicine. Teachers and investigators may teach doctrines in

one decade which are discarded in the next; nevertheless, there is no body of individuals more competent than they to decide what doctrines are right, and if mistakes have been made, as they are bound to be with the best of intentions, the teachers and investigators have proven themselves to be the first to discover and to rectify the errors without the assistance of uninformed outsiders. We are never absolutely certain as to what constitutes truth, but if there is any method of insuring that what is taught is true better than that of giving investigators and teachers the utmost freedom to discover and proclaim the truth as they see it, that method has never been discovered. If those who know most about a subject sometimes decide wrongly, matters are not likely to be mended by putting the decision into the hands of those who know less.

Some of the proposed laws in regard to the teaching of evolution would forbid this doctrine to be taught as fact, while permitting it to be presented as theory. If such laws are justified at all, they should apply to all theoretical questions instead of singling out the theory of evolution for special attack. A teacher in any field is under a moral obligation not to teach as a fact a doctrine which is not yet established. But who is to decide what can reasonably be held as settled fact, and what is still in the realm of uncertainty? Most well-established generalizations begin as theories before they are finally accepted as truisms. This was true of the theory of the rotundity of the earth, although a minority might protest even now against teaching dogmatically that this theory is proven. The line between fact and theory would be drawn differently by different teachers. The attempt to settle such questions by law instead of allowing them to settle themselves in the light of advancing knowledge would create only endless mischief and confusion. The theory of evolution is one of those generalizations which are so far along on the high road to general acceptance as an established truth that teachers of biology differ as to whether, for practical purposes, it should be classed as fact or theory. So long as students as well as teachers are aware that there is a small measure of uncertainty attaching to most things regarded as facts, the distinction between what is called fact and what is an extremely probable theory is not one which urgently needs to be recognized by legislative enactment, especially since there is no way in which such questions can really be settled except through the advancement of knowledge.

The attempts which have been made to suppress all teaching of evolutionary theory, even as theory, are a menace not only to freedom, but to liberal education. Whatever one may think of the doctrine of evolution, he can not fail to recognize the fact that it has profoundly influenced thought not only in the biological sciences, but in psychology, sociology, education, ethics, political science, philosophy and many other fields of human knowledge. It is a doctrine, therefore, with which every person with any pretense to a liberal education should be familiar. Efforts to keep students from knowing about it are not only futile, but they constitute a violation of the rights of students to know what is the consensus of the best opinion on a great problem. Students have a right to know the pros and cons of controverted subjects in every field. Teachers should be free to present those subjects and to express their own position in regard to them. It is only the things that are not true which have anything to fear from freedom of discussion, and it is only by the maintenance of this freedom that we create conditions under which the truth will most rapidly prevail.

JOSEPH ALLEN,
J. H. BREASTED,
G. A. COE,
E. G. CONKLIN,
JOHN DEWEY,
R. F. GRIGGS,
VERNON KELLOGG,
SHAILER MATHEWS,
R. A. MILLIKAN,
E. C. MOORE,
HERBERT OSBORN,
W. PATTEN,
A. H. TURNER,
H. E. WALTER,
W. H. WELCH,
S. J. HOLMES, *chairman*

THE SECOND ANNUAL AMERICAN ASSOCIATION PRIZE

THE second annual prize of one thousand dollars has been divided this year into two equal prizes and these have been awarded (as already announced in SCIENCE for February 13) to Dr. L. R. Cleveland, of the School of Hygiene and Public Health of the Johns Hopkins University, and to Dr. Edwin P. Hubble, of the Mt. Wilson Observatory of the Carnegie Institution of Washington. It will be recalled that these annual prizes have been made possible through the public-spirited action of a member of the American Association whose name is to be withheld. The amount available is one thousand dollars each year and the awards are to be made for noteworthy contributions to science presented at the annual meetings of the American Association and associated societies. Four more years after the present are thus far provided for. The awards now announced are for papers presented at the recent Washington meeting.

Dr. Cleveland holds a National Research Council fellowship in biology and is engaged in research in medical zoology at the School of Hygiene and Public Health of the Johns Hopkins University, Baltimore. He received his bachelor's degree at the University of Mississippi in 1917 and the degree of doctor of science at Johns Hopkins University in 1923. He was instructor in biology in the University of Mississippi, 1916–18; in Emory University, 1918–20; instructor in zoology in Kansas State Agricultural College, 1920–21, and research fellow at Johns Hopkins University, 1921–23.

Dr. Cleveland presented two papers at the Washington meeting, in the program of the American Society of Zoologists, with the following titles: "The ability of termites to live perhaps indefinitely on a diet of pure cellulose," and "The effects of starvation and oxygenation on the symbiosis between termites and their intestinal protozoa, together with the toxicity of oxygen for free-living and parasitic protozoa." The following is a summary of the research work represented by the papers that won the prize, these notes having been kindly furnished to the permanent secretary's office by Dr. Cleveland.

Approximately 1,200 species of termites, or white ants, are known, most of which feed on wood. All that harbor protozoa are wood feeders. Some of these have been fed only pure cellulose for two years, with no signs of disturbance in nutrition or reproduction. These termites may without injury be freed from protozoa by 24-hour incubation at 36° C. or by confinement in oxygen at a pressure of 3.5 atmospheres for 40 minutes. Oxygen at several other pressures acts in the same manner. Mechanical gas pressure does not offer an explanation and the results are apparently to be related to a differential toxicity of oxygen. Starvation treatment kills all individuals of some genera of protozoa long before their termite hosts succumb. It has been possible to work out the relation of each protozoon to its host and to its fellow-protozoa. Probably all protozoa-harboring termites are dependent on the protozoa to digest their food for them. In the large Pacific Coast termite, *Termopsis,* either of the protozoa *Trichonympha* or *Leidyopsis* is able to keep its host alive indefinitely; *Trichomonas* is of some value as a symbiont; *Streblomastix* is of no value. When the essential protozoa are removed, the termites do not live more than three to four weeks on their normal diet of wood, although they live indefinitely on humus or on fungus-digested cellulose. If reinfected with protozoa, they become again able to live indefinitely on a wood diet.

The toxicity of oxygen for many parasitic and free-living protozoa has been determined. At a pressure of 3.5 atmospheres it is 50 times as toxic for the protozoa of termites as for the termites themselves. Cockroaches harbor many kinds of protozoa, all of which are killed by oxygenation at 3.5 atmospheres for 3.5 hours; the flagellates *Lophomonas* and *Polymastix* were killed in 40 minutes and the ciliates *Nyctotherus* and *Balantidium* in 3.5 hours; while the cockroaches themselves were not killed until the treatment had lasted 90 hours. Oxygen at this pressure is therefore 136 times as toxic for the flagellates and 26 times as toxic for the ciliates living in cockroaches as for the insects themselves. Earthworms when oxygenated lose their ciliates. Frogs harbor many protozoa. Oxygenation at 3.5 atmospheres of pressure kills *Hexamitus* in 5, *Polymastix* in 7, *Trichomonas* in 12, *Opalina* in 18, *Nyctotherus* in 28, and the frog in 65 hours. Oxygenation may probably remove the protozoa from all invertebrates and cold-blooded vertebrates without injury to the hosts. *Trichomonas* from frog, rat and man was oxygenated in culture and killed, but it has been found impossible to remove this organism from rats and man by oxygenation at a pressure of 3.5 atmospheres. The toxicity of oxygen for many free-living protozoa also has been determined. Oxygen is certainly just as toxic for some free-living ciliates as it is for parasitic ciliates; for others it is not. For *Paramoecium* and *Chilodion,* it is more toxic than for the parasitic forms: for *Diophrys* and *Holostica,* it is considerably less toxic.

Dr. Hubble holds the position of astronomer at the Mt. Wilson Observatory, Pasadena. He received his bachelor's degree at the University of Chicago in 1910, and his Ph.D. at the same university in 1917. He holds the degree M.A. from Oxford. Before appointment to his present position he was assistant in the Yerkes Observatory.

The paper for which the prize was awarded was presented in the joint program of the Mathematics, Physics and Astronomy sections of the Association, the title being "Cepheids in spiral nebulae." The researches thus represented are outlined below from notes kindly supplied by Dr. Hubble.

There are two sorts of nebulae. Galactic nebulae belong to our own stellar system, clouds of dust and gas excited to luminosity by some sort of radiation from involved or neighboring stars. Non-galactic nebulae, including the spirals, are outside of our stellar system and no definite data have hitherto been available concerning the fundamental problem of their distance, nor have promising methods been formulated heretofore for investigating their composition, structure and forces. It is with these non-galactic nebulae that these studies have dealt.

The significant feature of the present investigation is the partial resolution of the largest and brightest spirals into swarms of actual stars. This was accomplished by the use of the largest telescope in existence, being quite beyond the capacity of smaller instruments. As a first example of the methods and results of Dr. Hubble's work, Cepheid variables, almost always present in the great isolated systems of stars, have been found and employed as a criterion of distance. The paper presented at the Washington meeting gave a hasty summary of the results of this particular phase. The results are checked by a study of novae, distribution of stellar colors and of stellar luminosities in the spirals. There is little

doubt that the general principle of the uniformity of nature applies here and that the stars of non-galactic nebulae are the same sort of bodies with which we are familiar in our local system. But the most important feature is in the background of the paper, the uncovering of targets for the heavy artillery of methods for stellar investigation.

The author's abstract of the paper presented at the meeting is as follows: "On photographs made with the 100-inch and 60-inch reflectors of the Mount Wilson Observatory, the outer regions of the two spirals M 31 and M 33 are resolved into dense swarms of actual stars. Many of these stars are variable and of the variables a large percentage are Cepheids. Normal curves, periods and photographic magnitudes have been determined for 22 Cepheids in M 33 and 12 in M 31. The magnitudes at maximum run from 18.1 to 19.1 and the periods from 18 to 50 days. The period-luminosity relation is conspicuously present. The distances, as derived from Shapley's period-luminosity curve, are the same for both nebulae—about 285,000 parsecs. Variables have also been found in M 81, M 101 and N. G. C. 2403, but nothing is known as yet of their periods."—B. E. L.

SCIENTIFIC EVENTS

INTERNATIONAL ANNUAL TABLES

DR. CHARLES MARIE, general secretary of the International Commission charged with the compilation and publication of "International Annual Tables of Constants and Numerical Data, Physical, Chemical and Technological," announces the publication of Volume 5, Part 1. This volume gives all numerical data which characterize any substance, material or system which are to be found in the world's literature for the period of 1917–1922, inclusive, and covers the sciences of physics, chemistry, mineralogy, biology and the various branches of technology. Owing to the large volume of modern scientific literature, these volumes will be of great value to scientific men having occasion to use numerical data. The volumes give not only the data as they appear in the original literature, but also the corresponding literature reference for every value recorded.

This international undertaking is carried on without profit and is made possible by the financial support of governments, scientific societies and educational institutions which contribute to the international fund. Members of scientific organizations and of the faculties of universities which help in this way to make possible the compilation of annual tables are accorded a special discount on purchases of these volumes. The volumes are distributed in the United States through the University of Chicago Press. The following is a list of American contributors to the international fund:

1. *Scientific Organizations:*
   American Association for the Advancement of Science
   National Academy of Sciences
   National Research Council
   American Philosophical Society
   American Academy of Arts and Sciences
   Philosophical Society of Washington
   American Institute of Chemical Engineers
   American Institute of Electrical Engineers
   American Electrochemical Society
   American Chemical Society
   American Ceramic Society
   American Society of Civil Engineers
   American Society of Mechanical Engineers
   American Society for Testing Materials
   American Institute of Mining and Metallurgical Engineers
   American Medical Association
   American Physical Society
2. *Educational Institutions:*
   Stanford University
   University of California
   University of Minnesota
   Ohio State University
   Cornell University
   University of Buffalo
   Columbia University
   Johns Hopkins University
3. *Industrial Organizations:*
   New Jersey Zinc Company

E. W. WASHBURN,
American Commissioner

THE THIRD ASIATIC EXPEDITION OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE members of the Third Asiatic Expedition of the American Museum of Natural History, New York, sailed from San Francisco on the *President Lincoln* on March 7 for China. This is the largest scientific expedition ever sent out by the museum. The party sails to meet Roy Chapman Andrews, leader of the Third Asiatic Expedition, to commence its third year's work in China and Mongolia. The personnel of the party is as follows:

Walter Granger, paleontologist and second in command.

Dr. Charles P. Berkey, geologist, professor of geology at Columbia University.

Frederick Morris, assistant geologist, previously of Columbia University and Peyang University in Tientsin.

Major L. B. Roberts, topographer, member of United States aerial mapping force in France during the war. Resident of Kansas City.

Dr. Ralph W. Chaney, botanist and paleobotanist of Carnegie Institution of Washington.

J. B. Shackleford, cinematographer of New York City.

Dr. N. C. Nelson, archeologist of the American Museum of Natural History.

George Olsen, assistant in paleontology, American Museum of Natural History.

J. McKenzie Young, in charge of motor transportation, formerly of the U. S. Marine Corps.

Norman Lovell, assistant in motor transportation, an American resident of Peking.

Dr. Skinner, surgeon, resident of Hankow.

Lieut. Butler, assistant topographer, on staff of commander of American military force in China.

Lieut. Robinson, assistant topographer of British army stationed at Peking.

Another member of the party, Mr. Clifford H. Pope, assistant zoologist of the American Museum of Natural History, who will work in South China has just arrived in Peking.

The party expects to reach Peking about April 2 and will leave for Mongolia on April 15, proceeding from Peking to Kalgan. On April 17 they will start out from Kalgan with motor cars equipped with two weeks' provisions for the 900 mile trip to Tsagan Nor.

Mr. Andrews, who left the museum in May after six months in New York, arrived in Peking early in July. He immediately commenced arrangements for the field season of 1925 by visiting Urga in August and carrying on negotiations with the Mongol government to continue explorations in outer Mongolia.

Passports for all of the party have been secured and they will be able to carry on the work as planned without interruption. For the summer's work a caravan of 150 camels has been assembled at Kalgan, the gateway to Mongolia, and a large amount of equipment and provisions necessary for the expedition has been brought together at the expedition's headquarters in Peking.

As in previous years, the transportation of the party will be by motor cars, five Dodge cars and two Fulton trucks. The same route for the 900 miles to Tsagan Nor will be followed as was used on previous trips, but beyond that the party will again do pioneering work by motor into the great Gobi Desert.

From Tsagan Nor, the western-most point previously reached by the expedition, the party will proceed northwest into a new country with no special objective in view beyond the exploration of the strip of desert which extends along the north base of the Altai Mountains and the general study of the topography of the region. The geologists of the party will make various side trips and the topographers will also be away from the main party at various times in order to map as much of the surrounding country as possible. The archeologists will search particularly for evidences of the earliest inhabitants of the region, the Pre-Mongolian races. The zoologists will fill the time collecting the birds, mammals and other forms of life there at the present time.

As before, the principal efforts of the party will be directed along paleontological lines. The two years' work already done in Mongolia yielded valuable results in this field, giving an insight into the animal life of this hitherto unknown region at nine different stages of its history. These stages cover the period of many millions of years and extend well back in the Age of Reptiles and well down to the advent of man. It is hoped that the expedition of the coming season will result in the discovery of new fossil-bearing formations and thus give added links in the chain of the evolution of life in this part of the world.

All the work of the Third Asiatic Expedition has been made possible through the generosity of the friends of the museum who have liberally contributed to its support, and with the cooperation of the magazine *Asia*.

PLANS OF THE NEW YORK ACADEMY OF MEDICINE

PLANS for the expansion in the activities of the New York Academy of Medicine during the next three years were announced at the academy's annual meeting recently, when Dr. George David Stewart retired as president and Dr. Samuel A. Brown took the chair.

During that time their new building will be constructed at 103d Street and Fifth Avenue. The plans were considered as far back as 1910. Under the direction of the Building Committee, Messrs. York and Sawyer were selected as architects to prepare plans for a building to be situated at Sixtieth Street and Park Avenue. It was estimated at the time that the plans for the building at Sixtieth Street would have cost $2,200,000. The Carnegie Corporation had already given the academy $1,000,000 to be used to partially defray the cost of a new building, but its officers made it clear that it would not be possible for them to appropriate the additional $1,200,000. It was therefore decided to construct a building to cost about $1,500,000 and to sell the site at Sixtieth Street and Park Avenue.

Plans for the building have been approved with the exception of the facade. The auditorium will be 56 feet by 74 feet and will seat on its main floor 528 persons. There will also be a gallery which will seat 171 persons, making a total of 699. There will be a platform at the east end of the auditorium with ample space for guests, a speaker's desk, reading desk and secretary's desk.

The main building will contain the necessary machinery for heating and ventilation in the basement

and also a kitchen and lavatory. On the entrance floor there will be a main hall, a reception room or lounge and a pantry.

The library and main reading room will be situated on the third floor and extend through the entire north end of the main building. It will seat 116 persons, which is more than the average daily attendance in the present building.

In addition there will be a journal room which will seat at least sixty persons, and these two rooms are to have bookcases which will hold about 10,000 books. There will also be a small room for members where conversation will be permitted. Study rooms reserved for special students will be on the mezzanine floor, convenient of access from the library.

The book stack will be four full stories high or eight stack stories of seven feet each and will be able to hold approximately 327,000 books. It is so arranged that its heights may be doubled and space also reserved so that the size of the stack may be enlarged for the future storage of nearly a million books. The stack when complete will provide for all the books of the academy at its present rate of growth for forty-five years.

Additional educational activities will probably be undertaken by the academy upon occupying the new home. Dr. Stewart, the retiring president, recommended that the academy furnish information to the fellows and foreign students regarding clinical facilities at home and abroad, post-graduate instruction and opportunities for interneships in other cities over the country as well as New York. He expressed a hope that the academy will at some time find it feasible to open its library to undergraduate medical students studying at local colleges.

THE JUNGLE LABORATORY OF TROPICAL BIOLOGY CONDUCTED BY THE UNIVERSITY OF PITTSBURGH

THE Tropical Research Station of the New York Zoological Society located at Kartabo, British Guiana, has been turned over to the University of Pittsburgh for several years. During the summer of 1924 eight students worked at this jungle laboratory, through July and August, under the direction of Dr. Alfred Emerson, of the department of zoology. This experiment proved so successful that further courses are planned.

During the summer of 1925, a group of fifteen students will study at the laboratory under the direction of Dr. S. H. Williams, professor of zoology at the University of Pittsburgh. These students will be expected to work on individual problems for at least half their time and a course in ecology will be given by Dr. Williams for those who wish to enroll. The group will leave New York on the Trinidad Line about June 15 and will return about September 10. Credit will be allowed by the University of Pittsburgh for the work.

The expenses of each student will be approximately $700, including transportation, living expenses and incidentals from New York and return. Stops will be made at the West Indian islands of Grenada and Trinidad.

Through the employment of a permanent keeper at the laboratory, the equipment and facilities of the station will henceforth be open to visiting scientists at any time during the year.

All communications and applications should be addressed to Professor H. D. Fish, department of zoology, University of Pittsburgh, Pennsylvania.

ALFRED EMERSON
UNIVERSITY OF PITTSBURGH

SCIENTIFIC NOTES AND NEWS

DR. GILBERT N. LEWIS, dean of the college of chemistry at the University of California, will deliver the Silliman lectures at Yale University for the year 1925–26.

THE University of Pittsburgh in connection with its Charter Day exercises on February 27, conferred the degree of Sc.D. on William Schaus, honorary assistant curator of the division of insects in the United States National Museum, and on William Felton Barrett, vice-president of the Prest-O-Lite Company, Inc. and the Union Carbide and Carbon Research Laboratories, Inc., of New York, N. Y.

DR. D. T. MACDOUGAL, of the Desert Laboratory, Carnegie Institution of Washington, has been elected a corresponding member of the Czecho-Slovakian Botanical Society.

PROFESSOR FREDERIC S. LEE, of Columbia University, has been appointed a member of the correspondence committee on industrial hygiene of the International Bureau of Labor, one of the departments of the League of Nations.

ARISTIDES AGRAMONTE, professor of bacteriology at the University of Havana and delegate from Cuba to the Third Pan-American Scientific Congress, has received the honorary degree of doctor of science from the University of San Marcos, Lima, Peru, and has also been made corresponding member of the National Academy of Medicine, of Peru.

PROFESSOR A. MONTI, of Pavia, has been awarded the Valier prize by the Venetian Institute of Science for his work, "Malaria in the Italian War Zone, 1915–1919."

M. HENRY VALLOT, founder and director of the Mont-Blanc Observatory, has been made an officer of the Légion d'Honneur.

DR. JAMES HOPWOOD JEANS, F.R.S., secretary of the Royal Society, and Sir William Henry Ellis have been appointed members of the advisory council to the committee of the Privy Council for Scientific and Industrial Research.

THE following officers of the Royal Astronomical Society were elected at the anniversary meeting on February 13: *President,* Dr. J. H. Jeans; *vice-presidents,* Dr. A. C. D. Crommelin, Dr. J. L. E. Dreyer, Professor A. Fowler, Dr. J. W. L. Glaisher; *treasurer,* Lieut.-Col. F. J. M. Stratton; *secretaries,* Dr. J. Jackson, Rev. T. E. R. Phillips; *foreign secretary,* Professor H. H. Turner.

THE Council of the Chemical Society of England has nominated Dr. Arthur W. Crossley as president, Dr. T. Slater Price as secretary and Professor F. G. Donnan as foreign secretary. The annual general meeting will be held on March 26, and the anniversary dinner will be held the same evening.

PROFESSOR SIMMONDS, emeritus professor of pathological anatomy at the University of Hamburg, celebrated his seventieth birthday on January 14.

PROFESSOR ALEXANDER ZIWET, of the department of mathematics in the University of Michigan, will retire at the end of the present academic year, after thirty-seven years of uninterrupted service in the department.

JOSEPH V. DE PORTE, professor of mathematics and statistics at the New York State College for Teachers, has been appointed director of the division of vital statistics of the New York State Department of Health, to succeed the late Dr. Otto R. Eichel.

PROFESSOR MARK ALFRED CARLETON, previously plant pathologist for the Cuyamel Fruit Company, investigating the Panama disease of bananas, has resigned to accept the position of director of the Cotton Plague Laboratory of northern Peru at Piura.

E. D. BOTTS, until recently assistant professor of chemistry at the University of Louisville, has been appointed research chemist with the American Marine Paint Company, San Francisco.

DR. L. M. HENDERSON has resigned as assistant professor of physical chemistry at the University of Minnesota, to accept a position as research chemist with the Atlantic Refining Company of Philadelphia.

DR. G. R. ROSS, lecturer in bacteriology at the University of Leeds, England, has been appointed Rhodesian Research Fellow at the London School of Hygiene and Tropical Medicine. Dr. Ross leaves for southern Rhodesia early in March, where he will undertake a study of the etiology and pathology of blackwater fever.

THE Italian correspondent of the *Journal* of the American Medical Association states that Professor Albertoni, of the chair of physiology at Bologna, has been invited by Professor Lafayette B. Mendel, director of the Sheffield laboratory of physiological chemistry at Yale University, to continue his research work there after his approaching retirement on account of the age limit.

DR. ARTHUR BROZEK, assistant professor of genetics and statistics in Charles University, Prague, is studying in America under the auspices of the Rockefeller Foundation.

DR. MAYME I. LOGSDON, of the University of Chicago, has been appointed to a fellowship by the General Education Board and will spend the year 1925–26 studying in Italy on subjects connected with higher geometry.

DR. N. L. BRITTON, director-in-chief of the New York Botanical Garden, sailed for Porto Rico and the Virgin Islands on January 22, accompanied by Mrs. Britton. They will continue botanical investigations commenced there several years ago, in cooperation with the insular governments and obtain plants and specimens desired for the collections at Bronx Park.

DR. F. L. STEVENS, professor of plant pathology at the University of Illinois, has returned from an extensive collecting trip, during which he visited many of the countries of South America for the purpose of securing parasitic fungi, also to attend the session in Peru of the Pan-American Scientific Congress.

DR. N. A. CLARK, of the department of chemistry at Iowa State College, will spend this summer becoming acquainted with the soils work of the various agricultural experiment stations of Great Britain, more especially with that of Rothamsted Station.

DR. HENRY C. SHERMAN, Mitchill professor of chemistry in Columbia University, lectured on enzymes and vitamins at the Iowa State College, February 16 and 17; Iowa State University, February 18; University of Minnesota, February 19 and 20; University of Illinois, February 23; University of Michigan, February 25; and on vitamins at the Ohio State University, February 26. The lectures were given under the joint auspices of the graduate schools or scientific societies of the college or university and the local sections of the American Chemical Society.

DR. R. B. SOSMAN, of the Geophysical Laboratory, Carnegie Institution of Washington, will give a series

of lectures on geophysics at the Massachusetts Institute of Technology in March and April.

DR. CHARLES R. STOCKARD, professor of anatomy at Cornell University Medical College, gave a lecture before the New York Academy of Sciences, section of biology, at the American Museum of Natural History, March 9, on "The problem of growth."

LIEUT.-COL. FIELDING H. GARRISON, Medical Corps, U. S. Army, held an informal historical conference on diabetes and insulin at the New York Academy of Medicine on February 21.

DR. ANTON J. CARLSON, professor of physiology at the University of Chicago, will give the Noble Wiley Jones lectures in Portland, March 23 to 26. The subjects will be: (1) "Gastric secretion in health and disease"; (2) "The problem of the endocrines" (two lectures); (3) "Motor disturbances of the alimentary canal," and (4) "The problem of the liver."

DR. WADE H. BROWN, of the Rockefeller Institute for Medical Research of New York City, will speak at the University of Michigan on March 19, on "Chemotherapy and treatment of syphilis."

ON February 14, Dr. Charles L. Reese, director of chemical research, E. I. du Pont de Nemours & Company, Delaware, delivered an address to the Royal Canadian Institute, Toronto, on the subject, "Twenty-five years' progress in explosives."

PROFESSOR JOHN PARKHURST, for twenty-five years a member of the staff of the Yerkes Observatory and associate professor of astronomy at the University of Chicago, died on March 1 at the age of sixty-three years.

DR. FREDERICK WALTON CARPENTER, J. P. Morgan professor of biology at Trinity College, died on March 1, aged forty-nine years.

JAMES WARD, professor of mental philosophy at Cambridge University, died on March 4, aged eighty-two years.

CHARLES HENRY WORDINGHAM, well-known British electrical engineer, died on January 28 at the age of fifty-eight years.

DR. BANTI, professor of morbid anatomy in the University of Florence, who had given his name to a form of splenic anemia, died recently.

PROFESSOR WALTHER DIECKMANN, of the department of chemistry in the University of Munich, died on January 12.

DR. WILHELM BORCHERS, professor of metallurgy and electrometallurgy at the Technische Hochschule of Aix-La-Chapelle, died on January 6, at the age of sixty-eight years.

THE regular meeting of the New York Section of the American Chemical Society was held at the Chemists' Club on March 6, when the William H. Nichols medal was presented to Dr. E. C. Franklin, of Leland Stanford University. The program was as follows: "Franklin as a friend," Dr. E. E. Slosson; "Franklin as a chemist," Dr. J. F. Norris, president of the American Chemical Society; "The alcohols, aldehydes and acids of the ammonia system," Dr. E. C. Franklin.

THE 132nd regular meeting of the American Physical Society was held in Pasadena, at the California Institute of Technology, in the Norman Bridge laboratory of physics, on March 7. Other meetings of the current season are as follows: 133. April 24 to 25, 1925, Washington. 134. June 18 or 19, 1925, Portland, Oregon, with the Pacific Division of the American Association for the Advancement of Science. 135. November 27 to 28, 1925, Chicago. 136. December 28 to 31, Kansas City. Annual meeting.

THE regular meeting of the Synapsis Club was held at the Citrus Experiment Station, Riverside, California, on March 2, at which time the following program was presented: John E. Dudley, Jr., University of Wisconsin, "Control of the pea aphis in Wisconsin"; Mohammed Kamal, Cairo, Egypt, "Agricultural activities in Egypt"; J. C. Chamberlin, University of California, Citrus Experiment Station, "Concerning the genus in systematic biology"; Dr. Lon A. Hawkins, United States Department of Agriculture, "Freezing temperatures and citrus fruits."

THE following is the program of the free illustrated lectures given at the New York Botanical Garden during March and April. They are to be held in the Museum Building on Saturdays, beginning at 3:30 P. M.: March 7, "Yosemite valley and the big trees," Dr. H. R. Rose; March 14, "Alpine flowers of the Rocky Mountains," Dr. P. A. Rydberg; March 21, "Plant cancers," Dr. Michael Levine; March 28, "Camping and collecting in the mountains of Chile," G. T. Hastings; April 4, "Porto Rico and the American Virgin Islands," Dr. F. J. Seaver; April 11, "Across the trail of Linnaeus in Arctic Lapland," Dr. G. C. Fisher; April 18, "European influences in American botany," Dr. J. H. Barnhart; April 25, "Flowers for the spring garden," K. R. Boynton.

THE National Medical Association of China is celebrating its tenth anniversary, the occasion being emphasized by a campaign to raise $100,000 for permanent headquarters for the association in Shanghai.

ACCORDING to the Dutch correspondent of the *Journal* of the American Medical Association, the steps taken to revive the permanent committee of the inter-

national congress of medicine as pertaining to industrial accidents have resulted in the reconstitution of international collaboration. Austria, Belgium, England, France, Germany, Italy, Russia and Switzerland have indicated their willingness to cooperate. National societies are being formed in several countries. A congress will probably be held in Amsterdam during the present year.

IT is reported that the 26-in. telescope sent to South Africa by Yale University will be erected in Milner Park, Johannesburg, close to the Witwatersrand University buildings, and that probably it will be in use within the next three or four months.

UNIVERSITY AND EDUCATIONAL NOTES

AMONG the educational institutions which will benefit under the will of the late Edmund C. Converse, of New York, are Amherst, Bowdoin, Dartmouth, Leland Stanford, Oberlin, Smith, Trinity, Tuskegee, Wells and Williams colleges. The amount has not yet been made public.

THE University of Washington has recently come into possession of a gift of $100,000 through the will of Mrs. Josephine McDermott, prominent for many years in commercial and philanthropic work in Seattle. The money is to be invested and the income applied mainly to research work in tuberculosis.

A CHICAGO physician, who has requested that his name be withheld, has given $150,000 to Northwestern University Medical School for instruction to students in clinical medicine.

DR. PERCY T. WALDEN, professor of chemistry at Yale University, has been appointed dean of the freshman year at the university, to succeed Dean Roswell Parker Angier, who has resigned.

ASSOCIATE PROFESSOR JOS. B. REYNOLDS has been made acting head of the department of mathematics and astronomy at Lehigh University following the death of Professor P. A. Lambert, head of the department.

THE University of Michigan has appointed Dr. James Deacon Bruce, Saginaw, director of the department of internal medicine at the medical school and chief of the medical service in University Hospital, Ann Arbor.

V. G. HELLER has accepted a position as assistant professor of physiological chemistry in the Oklahoma Agricultural and Mechanical College.

AT the University of Arizona the following additions to the faculty of the College of Mines and Engineering have been made: F. W. Garran, assistant professor of civil engineering; Wm. M. Kellogg, instructor in electrical engineering; M. L. Thornburg, assistant professor of mechanical engineering; M. J. Leahy, instructor in mechanical engineering; T. S. Lovering, instructor in geology; C. J. Cunningham, professor of metallurgy and ore dressing.

DR. WALTER MAKOWER, chief physicist to the Dunlop Rubber Company, has been appointed professor of science at the Royal Military Academy, England, in succession to Professor J. Young, retired.

DR. FRITZ HILDEBRANDT, lecturer at the University of Heidelberg, has been offered the chair of pharmacology at the Medical Academy in Düsseldorf.

DISCUSSION AND CORRESPONDENCE

ALMSHOUSE PAUPERS IN THE UNITED STATES

A PAPER printed in the October 31, 1924, issue of SCIENCE (page 394) by Professor Raymond Pearl arrived at two chief conclusions: (1) "It would appear that any social indictment of the Negro race, as a race, in respect of pauperism would probably be difficult to maintain." (2) "With a few trifling exceptions, all countries from which the present law *encourages* immigration contributed to almshouse pauperism in 1923 in *excess* of their representation in the population of 1920. On the other hand, again with a few trifling exceptions, those countries from which the present immigration law was especially framed to *discourage* immigration . . . contributed a *smaller* proportion to almshouse pauperism in 1923 than their representation in the general population of 1920."

Is it not true that Professor Pearl fails to consider the effect of geographical location of the great bulk of the Negro race, 85 per cent. of whom lived in the southern states (those south of Mason and Dixon's line, the Ohio River, Missouri and Kansas)? Here almshouses are not so essential an institution because of the milder climate, while in addition to the need in the north, we find the wealth, making possible the support of a considerable number of almshouses. There is a marked correlation between the per capita wealth of the several states and the number of almshouse paupers per 10,000 of the population.

The census of almshouse paupers was taken in midwinter, January 1, 1923. The northern almshouses would, at that time, be filled to capacity, largely with white paupers. The turnover, or the number of discharges in relation to the total number of inmates, per year, was three times as great in the four northern

states, Massachusetts, New York, Ohio and Illinois, as it was in South Carolina, Georgia, Alabama and Mississippi, indicating that climate has a significant effect upon almshouse pauperism.

No figures showing number of paupers by states for 1923 are available. Such figures may be obtained, however, from the 1910 census of paupers in almshouses. In New York Negroes contributed 1.5 to the general population and 1.6 to the almshouse population. In Illinois, the figures are 1.9 in the general population and 2.6 in the almshouse population; in Indiana Negroes contributed 2.2 and 3.9, in Pennsylvania 2.5 and 4.1 and in Ohio 2.3 and 5.1, respectively. In every state mentioned above the Negroes contributed to almshouse pauperism in excess of their representation in the population.

Nearly 40 per cent. of paupers in almshouses are over 70 years of age. Pauperism, then, is predominantly associated with old age. Consider that fact in connection with the figures of national immigration. According to Professor Pearl's diagram Italian and Russian immigrants showed the smallest proportionate contribution to the almshouse population; German and Irish the largest. Half of the Irish immigration came before 1867, half of the German before 1874, but half of the Russians have arrived since 1907 and half of the Italians since 1906. Patently, therefore, there is a much larger proportion of Irish and Germans who are over 70 years of age. No such conclusions as those of Professor Pearl can be drawn from the figures of the Census Bureau unless these considerations are allowed for.

PERCY L. CLARK, JR.
CORNELL UNIVERSITY

IN my former paper on almshouse pauperism (SCIENCE, Vol. 60, pp. 394–397) I attempted only to *describe* accurately and clearly, by both verbal and graphical methods, the latest *facts* about almshouse paupers in the United States. I drew no conclusions about the *reasons* why these facts are as they are, nor did I even discuss reasons. Nothing has so far disturbed my faith in the accuracy of the Census Bureau's collection of facts on this matter.

The essential point of Mr. Clark's paper seems to be that the Census Bureau figures do not furnish all the data necessary to determine the probable causes or reasons for the observed facts about almshouse pauperism. I was aware of this, and accordingly confined myself to a statement of facts.

The reasons put forward by Mr. Clark perhaps play some part in the case, but he has apparently overlooked some factors which my as yet inconclusive study of the matter leads me to believe are more important than those he discusses. For example the Negro (and in passing one may remark that Mr. Clark's excesses in Negro pauperism in selected northern states in 1910 would be more convincing if it were not for the fact, which he himself emphasizes, that most Negroes live in the south, and also for the fact that Negro almshouse pauperism has decreased since 1910 relatively more than has that of native whites) has a strong aversion to almshouses. The Negro people take care of their own poor and their orphans in their families to a degree which makes it difficult to maintain an almshouse or orphanage population. Occasionally in parts of the south even endowed institutions of this type have to shut down and go out of business because of lack of inmates. This same factor operates with certain other racial groups, particularly some of those of the recent immigration. Social workers among our foreign-born groups know this well. It is probably a much more important factor in explaining the lower incidence of almshouse population in these racial groups than the age distribution factor which Mr. Clark mentions, though of course that probably also does play some part. But Mr. Clark's contribution on this point is slightly misleading. He says: "Nearly 40 per cent. of paupers in almshouses are over 70 years of age." In 1910, the last year for which the age distribution figures for almshouse paupers are available, there were 84,198 paupers enumerated in almshouses on January 1. Of these 25,586 were 70 years of age or over. This works out to 30.4 per cent. This figure seems to be nearer 30 than 40.

RAYMOND PEARL
THE JOHNS HOPKINS UNIVERSITY

AN APPARENTLY OVERLOOKED SOURCE BOOK OF BIOLOGICAL HISTORY

THE translation of Aristotle's "Historia animalium," prepared by Armand Gaston Camus and published in Paris in 1783, has recently come to my attention for the first time. As a translation it is probably only one of many—lacking exceptional qualities. One may find a few references to it in the critical studies that have appeared since. In one regard, however, its possibilities have been largely overlooked. As a source book of biological history it seems to deserve more recognition.

The first of the two volumes contains the translation, the Greek and French being printed on opposite pages. The second volume is devoted to the "notes." Ordinarily the notes accompanying a translation from the classics are meaningful only to a Greek or Latin scholar, but that is not the case with those of Camus. In addition to a twenty-seven page résumé of the

history of "l'Histoire naturelle" from pre-Aristotelian times to near the end of the eighteenth century, Camus considers in order and at some length all the forms mentioned by Aristotle. I am unacquainted with any other notes that include as much. Notes may be found in "Aristoteles Thierkunde" of Aubert and Wimmer (Leipzig, 1868), but of a meager sort compared with those of Camus. Aubert and Wimmer did us the favor of assigning specific names to many of Aristotle's animals, but made little effort to do more in a biologic way. One finds in the older work, however, an analysis of the errors and truths in the "Historia animalium." More than that, Camus analyzes Aristotle's work not only in the light of that of Linnaeus, Buffon and others among his contemporaries, but in comparison with that of other ancients —Hippocrates, Aristophanes, Aelian and others—as well. In other words, the notes of the second volume of Camus's translation analyze Aristotle's statements in the light of more than twenty centuries of biological ("natural history") writings.

Needless to say, a work completed in 1783 can not be relied upon explicitly for all information it is purported to contain. But as a useful reference it surely has possibilities. The zoologist who is interested in tracing back to the very sources certain ideas (with regard to particular forms) stated or foreshadowed in Aristotle may be able to use this volume to good advantage as a limited bibliography. It is certainly worth reading by all who, having read the "Historia animalium," marvel at the remarkable number of facts accumulated by Aristotle.

GORDON ALEXANDER
PRINCETON UNIVERSITY

A PERPETUAL CALENDAR

I ASSUME that it is generally known that there is an organization in California with headquarters in San Francisco, I believe, whose purpose is to secure a revision of our present calendar. This organization proposes to introduce a calendar in which the year shall consist of 13 months of exactly 4 weeks, or 28 days each. They also propose to intercalate the remaining 365th day between the 13th and 1st months, and call it "New Year's Day." In like manner they propose to intercalate another day, every fourth year, at the middle of the year, and call it "Midsummer Holiday," or something similar.

The chief advantage claimed for this plan is that it gives a "perpetual calendar," that is, one that does not change from year to year. This is a very desirable feature, I am frank to admit, and I am heartily in favor of revising the calendar so as to secure this result. But this proposed plan seems to me to have two very serious disadvantages.

In the first place it differs so radically from the present calendar that it is very doubtful whether a sufficiently large number of the important nations of the world could be induced to consent to its adoption.

In the second place, in this proposed calendar the unit, the year, is divided into a prime number (13) of parts. To my mind this is a fatal defect. I know of no table of weights or measures now in use in which this is done.

Every mathematician knows that 12 would be a much better number for the radix of our system of natural numbers than ten. This is because twelve is divisible by 2, 3, 4 and 6, whereas ten is divisible by only 2 and 5. A system using 13 for a radix would be an abomination for very obvious reasons. For the same reasons it seems to me that whenever and however the calendar is revised, 12 should be retained as the number of months in the year.

A large number of business obligations are made to run for three, six and nine months. Interest on long time notes and bonds as well as dividends on most stocks are made payable either quarterly or semi-annually. A few companies pay dividends as often as six times a year. For simple convenience in conducting this enormous line of business, it is vastly more desirable to have the number of months divisible by 2, 4 and 6, rather than to have a prime number.

Furthermore, it is not necessary to make any radical change in the calendar now in use in order to secure a perpetual calendar. The simple plan herewith suggested involves only slight changes. One day is taken from March, and one day from August, and added to February; one day is taken from May and added to April; and the last day of December is set apart for "New Year's Day" the same as in the plan referred to above. Likewise the "Midsummer Holiday." This makes the year consist of four equal parts with three months or 91 days in each quarter. The first month in each of these four quarters, *viz.*, January, April, July and October, has 31 days, and the first day of each of these months will always fall on Monday; the second month of each quarter has 30 days with the first always on Thursday; and the third month in each quarter has 30 days with the first on Saturday. Thus the first day of a month would never fall on Sunday. Also an obligation running for any multiple of three months would always fall due on the same day of the week as that on which it was made.

Such a calendar as this could be put into effect some year when the first day of January falls on Monday without causing any appreciable disturbance in the larger affairs of the world. No important anniversaries in this country would be changed. A

comparatively small number of birthdays would be dislocated, but this would not be serious.

A. L. CANDY

UNIVERSITY OF NEBRASKA

QUOTATION WRONGLY CREDITED

SCIENTISTS often hold men of letters up to ridicule for their ignorance or misuse of scientific terms—and very properly. But now and then an opportunity comes for a turning of the tables, as, for example, on page 558 of SCIENCE for December 19, 1924, where Pasteur is credited with the well-known passage from the close of Robert Louis Stevenson's El Dorado: "To travel hopefully is a better thing than to arrive, and the true success is to labor."

FRED NEWTON SCOTT

DEPARTMENT OF RHETORIC
UNIVERSITY OF MICHIGAN

SCIENTIFIC BOOKS

A Bibliography of American Natural History. The Pioneer Century, 1769–1865. Vol. 1. An annotated bibliography of the publications relating to the history, biography and bibliography of American natural history and its institutions, during Colonial times and the pioneer century, which have been published up to 1924; with a classified subject and geographic index; and a bibliography of biographers. BY MAX MEISEL. Brooklyn, New York, The Premier Publishing Co. 244 pp. Price $5.00.

THE recent rather rapid extension of interest in Americana among libraries and bibliophiles and the growing attention paid to the historical development of scientific interests generally combine to make the publication of this bibliography both welcome and opportune. The classic series of papers by George Brown Goode on the history of American science, especially of natural history, of museums, of national scientific and educational institutions, of scientific congresses, of the United States National Museum and of the Smithsonian Institution furnishes a splendid résumé of the period covered by this bibliography, from the pen of one who took an active and by no means insignificant part in that pioneer period. This bibliography, which has utilized all the modern aids of library organization, will be of greatest assistance to some future historian who may seek to evaluate the effects of ideas, of the influences, both indigenous and foreign, of the leadership of men of ability and vision, of social groups and of environments which have inspired and moulded the development of American biology in the first century of its growth.

The scope of the work is an ambitious one and its proposed outline is as complete as bibliographic skill and training can make it. The author has been fortunate in receiving the personal aid of some who have had personal knowledge of the latter part of the era included, and also of those whose technical information in the wide range of subjects covered has been of great value in securing inclusiveness of pertinent titles especially of works in foreign periodicals, or of foreign publications, and of others whose titles afford no clue to the historical phases of their contents.

The work is more than a mere bibliography by virtue of the analysis and classification of the titles cited. The subjects included are the rôle played by scientific societies, scientific journals, natural history museums and botanic gardens, state geological and natural history surveys and federal exploring expeditions in the rise and progress of American botany, geology, mineralogy, paleontology and zoology. In the first volume the chronological list of institutions and publications which have fostered natural history in the United States is particularly instructive. So also are the annotations on the titles concerned with the history, biography and bibliography of American natural history; see, for example, the data on the group of members of the Philadelphia Academy who formed a center at New Harmony, Indiana. The classified subject index to the historical bibliography fills 37 pages and the geographic index 15 pages, while the bibliography of biographies, from John Abbot, the ornithologist, to Joseph Zentmayer, the maker of microscopes, fills almost a hundred pages. To scan the list is to gain a new vision of the wonderful galaxy of stars which illumined the dawn of American science—the Agassizs, Audubon, Baird, Barton, Bartram, Binney, Bonaparte, Brewer, Cassin, Cooper, Cope, Coues, Dana, Darlington, Elliott, Engelmann, Franklin, Gill, Gould, Gray, Guyot, Hagen, Haldeman, Hall, Hayden, Henry, the Hilgards, Hitchcock, Holbrook, Horn, Hyatt, Jefferson, Kalm, King, Lea, the Le Contes, Leidy, Lesquereux, Le Sueur, Marsh, Michaux, Newberry, Nuttall, Owen, Packard, Peale, Pickering, Pourtales, Powell, Putnam, Rafinesque, Rogers, Say, Scudder, Shaler, Silliman, Stimpson, Storer, Sullivant, Torrey, Tuckerman, Verrill, Whitney, Wilson, Winchell, Wistar, Wolle and Wyman.

The second and third volumes will contain the history of the institutions which have contributed to this field, bibliographies of their publications, and lists of their papers which deal with natural history. State surveys and expeditions will receive similar treatment. This will be followed by a full bibliography of books, articles and miscellaneous publications dealing with natural history and a chronological table of publications.

Indices of authors and institutions will also be provided. This bibliography when completed will

thus be a great convenience to the historian of the biological sciences and also to specialists in a number of fields, especially since American titles have often been so incompletely represented in European bibliographies of the last century.

CHARLES ATWOOD KOFOID
UNIVERSITY OF CALIFORNIA

LABORATORY APPARATUS AND METHODS

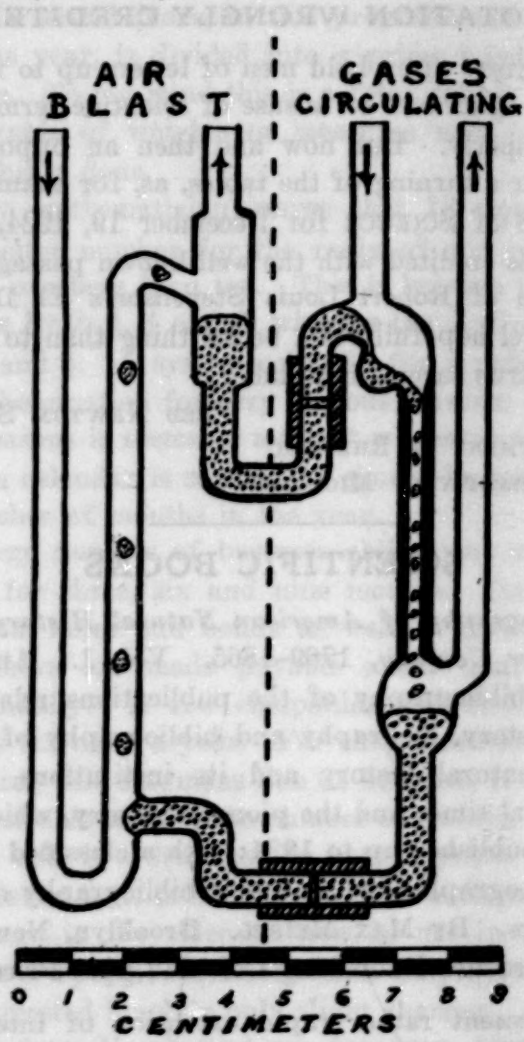
A SIMPLE CIRCULATION PUMP FOR GASES

THE physicist, the chemist and the biologist all may have occasion to pass continuously the same sample of gas at ordinary pressure over an object under investigation. This is commonly done by some form of circulation pump involving valves, which gives stepwise circulation and requires an individual motor. In meeting this problem, we have secured practically uniform and continuous flow by utilizing a very simple form of gas circulation, which uses for power the customary air-blast to be found in most laboratories. We believe a brief description of our apparatus will prove of interest to other workers.

The principle on which our apparatus functions may perhaps be made clear by an analogy. If one wished to circulate water round an annular trough, one might employ a paddle wheel operating at a constricted part of the annulus. In our gas-circulator, we paddle the gas round the closed system by means of a constant stream of droplets of mercury falling by gravity down a narrow tube which forms part of the circuit. This constant falling of mercury is reminiscent of the operation of a Sprengel pump, in which, however, the mercury droplets, by filling the bore of the fall-tube, act rather as pistons than as paddles. The portion of the figure to the right of the vertical dotted line shows the construction that serves the fall-tube.

The portion of the apparatus to the left of the dotted line is devoted solely to the purpose of raising the fallen mercury back to the level of the top of the fall-tube. Its action is precisely the converse of that of the right-hand portion, for here an air-blast from outside is employed to blow the mercury in droplets, which do not fill the bore of the rise-tube, from the low to the high level.

The entire apparatus as sketched is smaller than a man's open hand, and is constructed of glass tubing of 4 to 5 mm bore, except for the fall-tube, whose bore is about 2.5 mm. The two rubber connections shown in the figure make for ease in construction; and, in any case, the gases to be circulated come in contact only with glass and mercury. About 7 cc of mercury are sufficient. As in Bunsen and other pumps which incline to temperamentality, slight differences of construction sometimes lead to large changes in efficiency. A satisfactory model is furnished by the Eastern Instrument Company, 109 Oliver St., Newark, N. J.



A single such apparatus will circulate gases against back pressures in the circuit corresponding to a head of over 30 cm of water at a speed of two liters per hour; while, if the back pressure or resistance is negligible, the speed of circulation may exceed eight liters per hour. The consumption of air-blast air, at the customary six pounds pressure, is about one eighth of a cubic foot per minute, which is but half what a blast lamp uses. If greater volume of air circulation is desired, several such circulators may be used in parallel.

A. W. C. MENZIES
E. M. COLLINS
P. L. TYSON

PRINCETON, N. J.

SPECIAL ARTICLES

PROPAGATION OF ELECTROMAGNETIC WAVES OVER THE EARTH

AMONG the facts to be explained in a satisfactory theory of the propagation of radio waves over the

earth's surface are the curvature of the rays in transmission between stations far apart, the absorption during transmission, the peculiar phenomenon of fading in which the magnitude of the received wave fluctuates more or less rapidly, the differences in transmission in different directions over the earth and the extraordinary differences in the transmission of long and short waves.

This preliminary note is to outline a new theory of transmission which accounts quantitatively for many previously unexplained facts of radio transmission. A detailed treatment of important cases will appear shortly.

The atmosphere to a considerable height above the earth contains ions which react upon electromagnetic waves and, as shown by Larmor[1] may account for bending of long waves around the earth. His explanation, however, does not show the large and characteristic differences between short and long wave transmission which become especially marked in passing through the region between 100 and 200 meters. Other theories, also, have the defect of predicting entirely incorrect results for short wave lengths.

The theory now developed takes into account both the earth's magnetic field and the distribution of ionized particles in the atmosphere. It is found that this field, together with the electrons, produces marked selective effects at wave lengths between 100 and 200 meters and that these effects are different for different directions of transmission and for different planes of polarization of the wave. A summary of the effects follows.

For the case in which the electric force of the wave is parallel to the earth's magnetic field, the only effect is due to a variation in ionic density above the earth. This case is realized practically only over very limited areas of the earth's surface.

For transmission in any other direction or for any other direction of the electric field, four effects are in general produced, namely, the plane of polarization of the wave is rotated by an amount depending upon the density of free electrons, the magnetic field and the frequency. This effect reverses at the critical frequency which, for a field of one half gauss, is 1,400 kilocycles (214 meters). The second effect is that of double refraction in the medium, producing two waves of different velocities and polarizations. The third effect is a bending of the rays due to a variation in ionic concentration, as in Larmor's case, but, due to the magnetic field, this bending also, in most cases, reverses at the critical frequency, so that if long waves bend down in a certain region short waves will be deflected upward in the same region. The fourth effect is a bending of the rays due to variations in the magnetic field strength and this effect also reverses at the critical frequency.

The general solution of this problem can not be given in this note, but some interesting special cases will be described.

For transmission from a vertical antenna along a magnetic meridian the electric vector tends to be rotated and when this rotation becomes equal to 90°, the usual methods of reception produce no signals; hence we should expect, in general, better reception of east-west than of north-south signals at certain points. Also since the plane polarized ray can be resolved into two circularly polarized rays traveling with different velocities, under certain conditions both components may not be able to travel over the same path between two points.

The rotation of the plane of polarization for transmission along the magnetic field is rather large; for example, the electric vector in a wave 2 km long will turn from vertical to horizontal in about 80 wave lengths if there are present only 10 free electrons per cubic centimeter in a layer for which the mean free path is sufficiently long for free motion. A wave 100 meters long will rotate through the same angle, but in the opposite direction, in about 5,000 wave lengths or 500 km. For larger ionic densities, appropriate to high levels, the waves may be rotated very rapidly, which is one of the causes of variable transmission along a magnetic meridian.

For transmission at right angles to the magnetic field we find double refraction with the ordinary ray unaffected by the magnetic field, and the other selectively affected.

In all these cases, the variation in the number of ions and in the magnetic field at different heights above the earth produce deflections of the rays which may be calculated.

The introduction of a resistance term into the equations of motion of the electron leads to an attenuation factor in the equations of wave motion. Thus, for transmission parallel to the magnetic field the exponential term involves the reciprocal of the square of the frequency for frequencies sufficiently large compared to the critical value. This means, therefore, that attenuation due to this cause falls off rapidly as the frequency is increased. At the other extreme the same expression is found to apply except that in place of the transmitted frequency, the critical value is substituted. Hence in the range attenuation due to this cause is constant. There are, of course, other causes of attenuation, for example, the conductivity of the earth.

[1] *Phil. Mag.*, Dec., 1924.

When the frequency is near the critical value large anomalous effects occur. For example, the wave may be required to travel over a widely different path by a slight change in either the magnetic field or the ion density. The signal may arrive at the receiver from several directions simultaneously or successively, producing fading or apparent change of direction. The absorption may become extremely high for certain rays.

The detailed theory, with its predictions, will be published soon.

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CARBOHYDRATE STORAGE IN THE ENDOSPERM OF SWEET CORN

A STUDY of carbohydrate storage in the immature endosperm of sweet and waxy sweet corn has disclosed a kind of cell content not previously reported. It is a globule of cytoplasmic origin which stains red with iodine.[1] As these globules increase in size, smaller grains of solid carbohydrate are usually found within them.

The larger grains of carbohydrate, which occur both within the globules themselves and in the cells where the latter are not found, are compound and irregular in shape. There also are smaller, simple grains, ranging in size almost from the limit of visibility upward. In free-hand sections, these are found particularly in the globules and the globule-containing cells. The compound nature of the larger grains is the same in all the sweet corn studied, including the "pseudostarchy" type and has been described in one variety by Mottier in 1921.[2]

The grains of solid carbohydrate in ordinary (non-waxy) sweet corn, whether contained in globules or not, are of starch, and stain blue with iodine, whereas those in waxy sweet corn stain red. This red reaction of iodine with the carbohydrate present in the endosperm of waxy corn was reported by Weatherwax[3] in 1922. The fact that the reaction of the endosperm with iodine is similar in waxy and in waxy-sweet corn due to the nature of the grains of solid carbohydrate was reported by Kempton[4] in 1923. The identity of this carbohydrate has not been definitely determined. However, the further facts that it occurs in grains similar in form and development to the starch grains in non-waxy corn, and that these grains are digested by diastase[3] and are bright with a dark cross in polarized light, support Weatherwax in calling it a dextrin. They also indicate that it is related closely to starch.

The liquid portion of the globules apparently also is a dextrin, but nearer to sugar than are the grains of red staining carbohydrate. It is colloidal, stains red with iodine, is precipitated by alcohol and is digested by diastase. About one half of the polysaccharide content of the endosperm of sweet corn is in the form of globules, except in "pseudostarchy" corn in which there are fewer globules. The liquid portion of the globules probably is identical with the water-soluble polysaccharide obtained in analyses of immature sweet corn kernels by Culpepper and Magoon.[5] It has not been possible to isolate the globules from mature kernels of sweet corn. The membrane of the globule apparently disintegrates, the unaltered liquid portion becoming free within the cell. The nature of the membrane is unknown.

The globules of liquid carbohydrate and the grains of solid carbohydrate appear to develop from plastids imbedded in the cytoplasm. The origin and course of development of these plastids is the same in the endosperm of all the sweet corn studied. The larger granules in the cytoplasm, which may be called proplastids, show a conspicuous but temporary clumping about the nucleus during their development into plastids. This continues until the initiation of polysaccharide storage, at which time differentiation in the plastids is evident.

The kind of carbohydrate stored in the cell is governed by the genetic complex of the kernel. The recessive factor *su*, essential to the production of sweet endosperm, determines the development of the globules in both ordinary sweet and waxy sweet corn, together with the compound character of the larger grains of carbohydrate, and the reduced size of the simple grains. The carbohydrate of the grains in ordinary sweet corn, whether contained in the globules or not, is starch and is determined in development by the dominant factor *Wx*. The carbohydrate of the grains in waxy-sweet corn is determined in development by *wx*, which is essential to the production of their waxy character.

The development of the grains and of the globules in sweet corn apparently proceeds in a definite, orderly course up to the maturation of the endosperm. The accumulation of the liquid portion of the globules precedes the appearance of the carbohydrate grains within them and a surplus of this liquid is present at

[1] An aqueous solution of iodine in potassium iodide was used.

[2] Mottier, D. M., *Ann. Bot.*, Vol. 35, p. 357, 1921.

[3] Weatherwax, Paul, *Genetics*, Vol. 7, pp. 568–572, 1922.

[4] Kempton, J. H., SCIENCE, n. s., Vol. 57, pp. 556–557, 1923.

[5] Culpepper, C. W. and Magoon, C. A., *Jour. Agr. Res.*, Vol. 28, pp. 423–425, May, 1924.

all times. There is no evidence from our studies of a reversal of these processes or of any hydrolysis of the carbohydrate grains after they are formed. So far we have not found an intermediate polysaccharide not associated with the globules either in ordinary sweet corn, or in waxy sweet corn.

A more detailed description of carbohydrate storage in the endosperm of corn together with the experimental data will be published later.

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ORGANIZATIONS RELATED TO BOTH ZOOLOGY AND BOTANY AT THE WASHINGTON MEETING

(Reports for Sections F and G appeared in Science for February 6 and reports for the two corresponding groups of societies appeared in Science for February 27 and March 6)

The American Society of Naturalists

President, William H. Howell.

Secretary, A. Franklin Shull, University of Michigan, Ann Arbor, Mich.

(Report by A. Franklin Shull)

The American Society of Naturalists held sessions on only one day, Thursday. The morning session was devoted to an address by Dr. John C. Merriam, of the Carnegie Institution of Washington, on "Time and space as factors in the problem of evolution." In the afternoon was given a symposium on "Growth," participated in by Dr. Charles R. Stockard, with a paper on "The nature of growth from the standpoint of its deviations," and by Dr. D. T. MacDougal, who spoke on "Conditions of accretion and distention of plant cells." Two other papers, by Dr. Alexis Carrel and Dr. Lafayette B. Mendel, respectively, had been arranged for, but the speakers were unable to attend the meetings. The naturalists' dinner in the evening was followed by an address by the president, Professor William H. Howell, on "Theories of inhibition."

The Ecological Society of America

President, Edgar N. Transeau.

Secretary, A. O. Weese, University of Oklahoma, Norman, Okla.

(Report by A. O. Weese)

The society held sessions on four days beginning Monday, December 29. The opening session on Monday afternoon was a symposium on "Soil reaction," the chief participants in which were Frederick V. Coville, W. P. Kelley, C. S. Scofield and E. T. Wherry. The attendance at this session taxed the capacity of the meeting room and indicated widespread interest in this comparatively new field. The Wednesday afternoon symposium on "The plant and animal ecology of the coastal plain" was the second of a series, the first (on "The ecology of the Ohio region") having been held at Cincinnati this year. The interest aroused makes it probable that the series will be continued at Kansas City next year. Joint sessions were held with the Entomological Society of America on Tuesday, with the Botanical Society of America on Wednesday, and with the American Society of Zoologists on Thursday. Among the more important reports received at the business sessions were those of the representatives of the society on the Council of the Union of Biological Societies, that of the delegate to the National Conference on Outdoor Recreation and that of the representative on the Council on National Parks, Forests and Wild Life. Report of progress was made by the Glacier Bay Committee, and the editorial committee of the *Naturalists' Guide* reported that the manuscript of this important work had been turned over to the publisher. The Committee on the Preservation of Natural Conditions will continue its efforts to establish and protect natural areas. The officers elected for the coming year are: *President,* A. S. Pearse, University of Wisconsin; *vice-president,* J. E. Weaver, University of Nebraska; *secretary-treasurer,* A. O. Weese, University of Oklahoma. The representatives of the society in the Council of the American Association will be E. N. Transeau and W. C. Allee.

The American Microscopical Society

President, B. H. Ransom.

Secretary, Paul S. Welch, University of Michigan, Ann Arbor, Mich.

(Report by H. J. Van Cleave)

The forty-third annual meeting of the American Microscopical Society was held on December 31. Reports of officers comprised the chief business. Secretary Paul S. Welch tendered his resignation. In accepting the resignation, the society extended to Professor Welch a vote of appreciation. The following officers were elected: *President,* C. O. Esterly, Occidental College, Los Angeles; *first vice-president,* E. M. Gilbert, University of Wisconsin; *second vice-president,* A. M. Chickering, Albion College; *secretary,* H. J. Van Cleave, University of Illinois, for three

years; *treasurer,* Wm. F. Henderson, Mellon Institute, for one year; *custodian,* Magnus Pflaum, Philadelphia, for 2 years; *elective members of executive committee for 1925,* G. R. La Rue, University of Michigan; Z. P. Metcalf, North Carolina State College of Agriculture and Engineering; W. A. Hilton, Pomona College.

The American Nature-Study Society

President, M. R. Van Cleve.

Secretary-Editor, Mrs. Anna B. Comstock, 123 Roberts Place, Ithaca, N. Y.

(*Report by Anna B. Comstock*)

Following is a summary report of the Washington sessions. (1) Mrs. Elizabeth Peeples, director of nature study, schools of Washington, D. C., spoke on the various types of assistance which the U. S. Bureau of Forestry, the U. S. Weather Bureau, the U. S. Biological Survey and other government departments can render the nature-study teacher. Lists of bulletins and loans of slides and photographs are prepared by the department of agriculture for distribution to teachers upon request. (2) Dr. Harry Oberholser, of the U. S. Biological Survey, gave an address on conservation in which he laid down the principles of a sane conservation policy for animal life, based on exact knowledge of life habits and food, and giving due consideration to the needs of man and the balanced economy of nature. (3) Dr. Vernon Bailey, chief field naturalist, U. S. Biological Survey, gave a most valuable illustrated lecture on "Our friends and foes in the mouse world." The distinct economic value to man of some species was a revelation to many in the audience. (4) Mr. Arthur Newton Pack, associate editor, *Nature Magazine,* who was an active member of the committee on education of President Coolidge's recent Conference on Outdoor Recreation, spoke on the relation of the nature-study movement to the program of a more extensive use of outdoor recreation by the American people. A program of education in the schools which will train the children to see, understand and enjoy the phenomena of the out-of-doors will be of inestimable value. (5) Mrs. John D. Sherman, president of the General Federation of Women's Clubs of America, and intensive development of nature education in the schools, including the project of the establishment of a national normal school for the training of nature, presented the federation's plan for a more extensive and intensive development of nature education in the schools, including the project of the establishment of a national normal school for the training of nature-study teachers and supervisors. (6) Professor E. L. Palmer, professor of rural education in the New York College of Agriculture, Cornell University, presented a study of the nature-study interests among rural children, and some preliminary studies which seem to indicate striking differences between the science interests of city and rural children. He urged the city supervisors present to conduct more surveys among city children. Reports of committee chairmen were made on the following subjects: (a) "Survey of nature-study teaching in city schools," submitted by the chairman, Miss Clelia Paroni, supervisor of nature study in the schools of Berkeley, California. (b) "Survey of teaching of nature study in statewide programs for rural schools," submitted by Professor E. L. Palmer, of Cornell University. (c) "The problem of training teachers for nature-study teaching," submitted by the chairman, Professor W. G. Vinal, of the Rhode Island School of Education. (d) "Statement of the objectives in nature education and of the principles underlying the making of a course of study," submitted by the chairman, Mrs. Susan S. Albertis, Wilson Normal School, Washington, D. C. One session was given to an open discussion of several topics among which were: the relation of nature study to gardening, to geography and to general science; nature-study readers and text-books; correlation versus a special place on the school program. Professor M. R. Van Cleve, director of nature study and general science in the schools of Toledo, Ohio, was reelected president and Mrs. Anna B. Comstock, Ithaca, N. Y., was reelected secretary-editor.

The Phi Sigma Biological Society

President, Ira E. Cutler.

Secretary, C. I. Reid, University of Chicago, Chicago, Ill.

(*Report by the secretary*)

Phi Sigma Society held its first national convention on Monday, December 29, with two sessions. Delegates from every active chapter were present. The sessions were devoted to revising the constitution and reorganizing the society with a view to rendering greater service to beginning students in biological sciences, and to the laying down of a definite program as a national organization. The outstanding point of interest is the arrangement for a scientific program in connection with the next annual meeting of the American Association for the Advancement of Science, at Kansas City. This plan is of especial interest in view of the suggestion of retiring President Walcott that a junior section of the American Association be provided. It is the aim of Phi Sigma to partially fill that need in providing a place for younger students of biological sciences to report their initial efforts in research, regardless of the elementary

nature thereof. This arrangement has been made in the belief that not enough attention has been in the past devoted to the encouragement of research among younger students. It is believed that Phi Sigma can fulfill that need for the biological sciences and it is expected that the organization will in future devote its efforts solely to that end. It is not contemplated, however, that the society will become a rival to any existing organization serving a similar purpose.

The Genetics Sections of the American Society of Zoologists and the Botanical Society of America

Chairman, W. E. Castle.

Secretary, D. F. Jones, Connecticut Agricultural Experiment Station, New Haven, Conn.

(*Report by D. F. Jones*)

What part heredity and environment may have in determining certain characteristics in man received a definite answer from H. J. Muller, at the meeting of the Genetics Sections at Washington, who cited a case of twins separately reared from birth under conditions which were quite dissimilar. When tested at the age of 31, they were remarkably alike in their scores in intelligence tests. In striking contrast were the results of non-intellectual mental tests; in temperament, emotion, social attitude, association and tapping tests they consistently showed great differences, apparently to be explained by their different past experiences. This single case demonstrates very clearly that intelligence may be largely independent of environment and past experiences, while psychic differences may have very little genetic basis. A hypothesis to account for "crossing-over" in the peculiar chromosome situation which exists in Oenothera was presented by R. E. Cleland. Certain chromosomes were shown to form in rings. The formation of these rings and the way the chromosomes separate at cell division determines the association or disassociation of factors without the interchange of parts of chromosomes. The results of cytological investigations in many species of plants and animals were presented together with detailed facts of inheritance in many special fields. The effects of external modifying agencies, such as X-rays, upon the germplasm and the chromosome mechanism were reported in detail by several investigators. That a transplantable cancer may change in its ability to grow in certain strains of mice was stated by L. C. Strong. The origin of a fertile strain of Drosophila which is largely sterile when crossed with other strains, thus closely approximating the conditions in which species are separated in nature, was reported by H. H. Plough. Abstracts of all the papers were published in the *Anatomical Record,* for December 25, 1924, copies of which may be secured from the Wistar Institute as long as they are available. H. H. Bartlett was elected chairman for 1925, with F. D. Jones continuing as secretary.

ANTHROPOLOGICAL SOCIETIES AT THE WASHINGTON MEETING

(*A report for Section H appeared in Science for February 6.*)

American Anthropological Association

President, Aleš Hrdlička.

Secretary, A. V. Kidder, Andover, Mass.

(*Report by A. V. Kidder*)

The twenty-third annual meeting of the Anthropological Association was held in the National Museum on Thursday and Friday. In accordance with a custom that has been growing from year to year, the members confined themselves to the reading of papers on cultural subjects and presented their communications on physical anthropology at the sessions of Section H.

The retiring president, Dr. Walter Hough, opened the meeting on Thursday with an interesting paper on the distribution of an unusual type of chipped stone knife, examples of which have been found in New Mexico, Texas and other western areas. The bulk of the communications presented at this session were reports of field-work accomplished during the past year under the auspices of various institutions, such as the Smithsonian, the American School of Prehistoric Archeology in Europe, the National Geographic Society and the Museum of the American Indian. An encouraging feature was the evidently growing interest in anthropology throughout the Middle West, as evidenced by papers on Michigan archeology, and on the splendid collections of paleolithic material recently acquired by the Beloit Museum. Mr. Pond, of that museum, exhibited a series of original specimens of paleolithic carvings on stone and a magnificent necklace of Aurignacian period. On Friday there were papers of outstanding interest by Dr. E. Sapir, of the Victoria Memorial Museum, Ottawa, on "The Athabascan language;" by Dr. Elsie C. Parsons on "Tewa ceremonial," and by Dr. F. G. Speck on "The culture problems of the Northwest."

The American Folk-Lore Society

President, Elsie Clews Parsons.

Secretary, Gladys A. Reichard, Barnard College, New York City.

(*Report by Gladys A. Reichard*)

The annual meeting of the American Folk-Lore Society was held in the National Museum on Thursday,